**DEVELOPMENT OF A QUICK RESPONSE CODE-BASED CERTIFICATE AUTHENTICATION SYSTEM**

# COVER PAGE

**BY**

**USIIJU JOSEPH THLIZA**

**PGD/CSC/2023/7008**

**DEPARTMENT OF COMPUTER SCIENCE**

**ADAMAWA STATE UNIVERSITY MUBI**

**AUGUST, 2025**

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**USIIJU JOSEPH THLIZA**

**PGD/CSC/2023/7008**

**A PROJECT SUBMITTED TO THE COMPUTER SCIENCE DEPARTMENT ADAMAWA STATE UNIVERSITY, MUBI,**

**IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF POST GRADUATE DIPLOMA IN COMPUTER SCIENCE,**

**FACULTY OF SCIENCE ADAMAWA STATE UNIVERSITY, MUBI, NIGERIA.**

**AUGUST, 2025**

# CERTIFICATION

I **USIIJU JOSEPH THLIZA** hereby declare that this project titled “***Development of a Quick Response Code-Based Certificate Authentication System”*** has been carried out by me under the supervision of **DR. YUSUFU GAMBO.** All the materials and information used are properly acknowledged through reference.

# APPROVAL PAGE

This project titled “***Development of a Quick Response Code-Based Certificate Authentication System” by* USIIJU JOSEPH THLIZA PGD/CSC/2023/7008** has been examined and approved for the award of Post Graduate Diploma in Computer Science of the Adamawa State University, Mubi and is approved for its literary presentation and contribution to knowledge.

**DR. YUSUFU GAMBO ………………………… ………………………….**

(Project Supervisor) Sign Date

**DR. YUSUFU GAMBO ………………………… ………………………….**

(Head of Department) Sign Date

**PROF ALFRED D. MSHELIA ………………………… ………………………….**

(PGD Provost) Sign Date

**DEDICATION**

This project work is dedicated to Almighty God for His protection, wisdom, knowledge, and understanding throughout the period of my studies. This project work is also specially dedicated to my ever-beloved family.

**ACKNOWLEDGEMENTS**

I extend my profound gratitude to the Almighty God, my Creator, who has been my source of strength, wisdom, knowledge, and guidance throughout the journey of writing this project. From the very beginning to the successful completion of this endeavor, His infinite grace and blessings have been with me.

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# ABSTRACT

*The growing prevalence of counterfeit academic certificates has necessitated the development of secure, reliable, and efficient verification mechanisms. This research presents the design and implementation of a Quick Response (QR) Code-Based Certificate Authentication System aimed at enhancing the integrity of academic credential verification processes. The system generates unique QR codes embedded with encrypted certificate data, linked to a secure institutional database, enabling real-time online verification by employers, institutions, and other stakeholders. The study employs a user-friendly interface to facilitate accessibility while incorporating secure data handling practices to minimize the risk of forgery and unauthorized alterations. By automating certificate verification, the proposed solution significantly reduces administrative workload, shortens processing time, and improves accuracy compared to conventional manual methods. The system architecture emphasizes scalability, interoperability, and user-centric design, with potential integration into broader digital identity frameworks. Experimental implementation at Federal Polytechnic, Mubi, demonstrates the system’s efficiency, reliability, and potential for large-scale adoption. Recommendations include continuous security updates, blockchain integration for enhanced immutability, and mobile application development for broader accessibility. This work contributes a practical and adaptable model for secure digital certificate verification, addressing both technical and operational gaps in current practices.*

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background to the Study

In an increasingly digital world, the proliferation of counterfeit certificates and fraudulent claims of credentials has become a significant challenge for educational institutions, employers, and certification bodies. As technological advancements continue to evolve, it is imperative to leverage innovative solutions to combat this growing concern. One such solution is the implementation of a Quick Response (QR) Code-Based Certificate Authentication System, a secure and efficient mechanism that ensures the validity and authenticity of certificates issued by institutions (Hsu *et al*., 2022).

The traditional methods of verifying certificates often involve tedious, manual processes that are time-consuming, error-prone, and susceptible to manipulation (Chen *et al.,* 2023). This has resulted in a demand for more robust and automated systems capable of addressing these limitations. The use of QR codes, combined with modern encryption technologies, offers a scalable and cost-effective way to authenticate certificates. QR codes, as two-dimensional barcodes, can store vast amounts of data in a compact and easily accessible format, making them an ideal tool for certificate verification.

The increasing adoption of smartphones and internet connectivity globally has made QR codes a preferred technology in various domains, including education, healthcare, and commerce (Wang & Li, 2023). With a simple scan, a QR code can provide instant access to certificate details, ensuring that stakeholders can verify the authenticity of the document in real-time. This approach not only reduces the risk of forgery but also enhances trust and transparency in the certification process (UNESCO, 2021).

Recent studies have highlighted the growing concerns surrounding fraudulent certificates. According to Smith *et al.* (2022), educational institutions face reputational damage and financial losses due to the circulation of counterfeit certificates. Employers, too, are at risk of hiring unqualified individuals based on falsified credentials. These issues underscore the need for a secure, automated system that can mitigate such risks and streamline the verification process.

The QR Code-Based Certificate Authentication System can address these challenges by leveraging cutting-edge technologies to create a secure and efficient platform for certificate issuance and verification. The system utilizes QR codes embedded with encrypted data linked to a centralized database, ensuring that only authorized personnel can access and verify certificate details. By adopting this innovative approach, educational institutions and organizations can safeguard their credentials and maintain the integrity of their certification processes.

## 1.2 Problem Statement

The growing prevalence of certificate forgery and document falsification has emerged as a critical challenge across academic, professional, and governmental sectors. Despite the existence of conventional certificate authentication systems, many of these systems remain vulnerable due to limitations in manual verification processes, lack of real-time validation, and poor integration with secure digital platforms. Several studies have attempted to automate certificate verification; however, key gaps still persist in existing literature and practice.

While Abubakar and Suleiman (2022) described how most institutional systems remain siloed, recent studies confirm this continues as a widespread issue. Digital identity literature highlights that fragmented, non‑federated credential systems impede seamless cross-border verification whether for education, employment, or immigration purposes. Without compliance with open standards (e.g. ISO/IEC 20248 or federated interoperability frameworks), verifiers such as foreign employers or embassies cannot access certificate data outside the issuing institution’s ecosystem.

Ibrahim and Chinedu (2023) noted that many QR‑based systems embed static data within the QR code. More recent analyses show that such models still prevail QR content often includes only names, dates, or course details, with no live link to backend institutional databases. This static approach renders documents vulnerable to forgery and disconnection from real‑time status (e.g. revocation, updates).

Chen *et al.* (2023) argued that many implementations lack proper encryption or secure transmission. Continuing vulnerabilities include QR payloads stored as plain text or simple URLs, with no digital signature or tamper‑evident sealing. Modern standards (e.g. ISO/IEC 20248) advocate digitally‑signed payloads to support offline validation and detect tampering—but adoption remains limited.

Akinyemi *et al.* (2023) and Okonkwo *et al.* (2024) emphasized the user experience obstacle: in many settings especially rural or under‑resourced areas—technical complexity, non‑optimized mobile interfaces, and low digital literacy hinder adoption. Recent interoperability design guidance further underscores inclusive, user‑centric design as key to public trust but notes it is rarely implemented.

## 1.3 Aim and Objectives

The aim of this project is to provide a secured QR Code-Based Certificate Authentication System to enhance the security and efficiency of certificate verification processes with the following objectives;

1. Design a system that generates and embeds unique QR codes on certificates issued by educational institutions.
2. Develop a secure database system for storing and managing certificate information linked to QR codes.
3. Implement a user-friendly interface for stakeholders to verify certificate authenticity by scanning QR codes.

## 1.4 Significance of the Study

The successful implementation of a QR Code-Based Certificate Authentication System will have far-reaching benefits for educational institutions, employers, students, and other stakeholders:

The system will enhance the credibility and reputation of institutions by ensuring the authenticity of certificates issued. Automation of the verification process will reduce administrative burdens and improve operational efficiency. Institutions will be better equipped to combat certificate forgery and maintain the integrity of their credentials.

Employers will gain access to a reliable and efficient tool for verifying the qualifications of job applicants, reducing the risk of hiring unqualified individuals. The system will save time and resources spent on manual verification processes.

Certificate holders will benefit from increased trust in their credentials, enhancing their employability and academic opportunities. The QR code-based system will provide a convenient way for individuals to showcase their certificates and prove their authenticity.

The project will serve as a valuable reference for further studies on the application of technology in document authentication and security. Insights from the system's implementation can inform the development of policies and standards for digital certificate verification.

## 1.5 Scope of the Study

This project focuses on the development of a QR Code-Based Certificate Authentication System for educational institutions. The system will include the following features: Integration of QR codes on certificates issued to students, containing encrypted data linked to a centralized database, A web-based platform accessible to stakeholders for scanning QR codes and verifying certificate details, a secure database for storing certificate information, ensuring data integrity and protection against unauthorized access, role-based access control for administrators, students, and verifiers to ensure system security and Implementation of encryption and authentication mechanisms to prevent data tampering and ensure the privacy of certificate information.

## 1.6 Limitations of the Study

This study is limited in scope to the development and testing of a QR Code-Based Certificate Authentication System within the context of educational institutions. As such, the findings may not fully capture the requirements, operational challenges, or integration complexities faced by other sectors or institutions with different infrastructures. The system also relies on internet connectivity for real-time verification, which may hinder its effectiveness in regions with poor or unstable network coverage. Furthermore, the successful adoption of the system assumes a basic level of digital literacy among stakeholders; in rural or under-resourced areas, limited user competence may pose adoption challenges.

In addition, while the system incorporates encryption and authentication mechanisms to protect certificate data, it cannot fully eliminate security threats beyond its direct control, such as phishing, social engineering, or device-level compromises. The system’s performance is also dependent on the availability of compatible hardware and software, such as smartphones with functional cameras and up-to-date QR scanning applications. Lastly, differences in data protection regulations, interoperability standards, and institutional policies across regions may restrict the cross-border adoption and legal recognition of the system.

## 1.7 Definition of Operational Terms

**Authentication**: The process of verifying the validity and authenticity of a document or credential.

**Certificate**: An official document issued by an educational institution or organization to certify an individual's achievements or qualifications.

**Database**: A structured collection of data stored electronically and managed using software systems.

**Encryption**: A security technique used to protect data by converting it into an unreadable format, accessible only to authorized parties.

**QR Code**: A two-dimensional barcode that stores data in a compact and easily scannable format.

**Verification**: The process of confirming the authenticity and validity of a certificate using predefined methods or tools.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Overview

This chapter consist of previous project work carried out as related to the project, it sets the theoretical framework or base for the project and it also gives a brief explanation of the various terms pertaining to the research project.

## 2.2 Quick Response Code

QR codes have gained significant popularity in recent years due to their versatility and ease of use. They are two-dimensional barcodes that can store a large amount of information, including text, URLs, contact details, and other data, in a compact format. QR codes consist of black modules arranged on a white background, forming a square or rectangular shape. These codes can be scanned and decoded using mobile devices with camera functionality and QR code scanning applications (Wachirawutthichai *et al.,* 2022).

QR codes offer several advantages that make them suitable for various applications. They are easily readable by smartphones and can be scanned quickly, providing a seamless user experience. The error correction capabilities of QR codes allow for accurate decoding even if the code is partially damaged or distorted. Additionally, QR codes can store more information compared to traditional barcodes, making them ideal for storing complex data structures or URLs. Researchers and practitioners have explored the applications of QR codes in diverse fields. For instance, in marketing, QR codes are utilized to provide quick access to product information, promotions, or loyalty programs. They are also employed in ticketing systems, allowing users to easily access electronic tickets for events, transportation, or attractions. Furthermore, QR codes have found use in document verification, enabling the authentication and validation of various certificates, licenses, and identification documents (Yang et al., 2023).

Recent studies have focused on enhancing QR code technology to address specific requirements and challenges. For example, researchers have proposed techniques to improve the security of QR codes, such as incorporating encryption mechanisms to protect sensitive information encoded within the codes (Hsu *et al.,* 2022). Other studies have investigated methods to enhance the visual aesthetics of QR codes by incorporating design elements or patterns while preserving their scannability (Tang *et al.,* 2021).

## 2.3 Document verification

Document verification is a vast field such that there is bank type of documents, governmental type of documents, transactions type of document, educational certificates type of document and many more other kinds. Each of the domain and types can be treated differently and the content vary tremendously. For example, transactions can contain number in tabular form while educational certification may contain only textual information presented in paragraphs. Due to the vast differences in types of documents and how they are presented the research will focus on digital verification of paper-based graduation certificates.

Verification is the process of determining or confirming that someone (or something) is original. Documents Verification on the other hands can be define in various ways such as Warasart and Kuacharoen, (2012), defines document verification as the process of proving the correctness or authenticity of a document by using a proven method or technique. While the researchers Osman and Omar (2016), defines it as the process of ensuring that documents received from holder are genuine and that the holder is the rightful owner. Verification is the evidence that establishes or confirms the accuracy or truth of something while verifying is the act to prove the truth of, as by evidence or testimony.

A certificate verification is the act to prove that a certificate rightly and legally belongs to an organization or an individual or both. It is a computerized means of verifying someone’s claim of certificate- ship from an institution. Online Certificate Verification system improves the speed, quality of service of certificate authentication, globalization of markets, and cuts down cost (Nwachukwu & Igbajar, 2015). Educational establishments try to combat fraud and forgery in several ways, however, most of the methods are time-consuming because they are manual, partly automated or involve human to human interaction (Osman & Omar, 2016).

The main aim of document verification is the ability to trace the origins of a document to a specific person, the device that produced it or the place where it was produced (Srushti *et al.,* 2014). Forgeries pose a huge threat to the integrity of documents, with significant dangers in terms of authentication and trust. It is therefore important to protect the integrity of a document in order to prevent problems arising from the modification of a document by intruders (Srushti *et al.*, 2014). According to the research conducted by Nwachukwu and Igbajar (2015), all documents or credentials that are printed are potentially subject to counterfeiting and forgery. Forgery can cause a lot of damage when it comes to trust and authenticity (Hampo, 2011).

There is a high market for forgery as well as opportunity with low cost, high quality results available (Warasart, & Kuacharoen, 2012). Researchers have also found several significant problem areas when it comes to document verification. For instance, the technologies that are put forth to stop or prevent forgery do not seem to be moving as fast as the evolution of the forging techniques (Singhal, & Pavithr, 2015). With respect to academic documents, further authentication problems include the variations from one school to the next, which causes consistency issues that can be taken advantage of, especially in international situations (Boukar, Yusuf & Muslu, 2017).

There are two basic document categories that are considered in document verification literature; digital based documents and the traditional paper or printed document. The research in this case deals with certificates. Almost all documents can be handled in a digital manner, except for the certificate. The reason for this exception is that all digital documents are easy to forge without leaving any clues Tint and Win (2014). Furthermore, the prevalence of forged certificates results from the increased global demand for higher education, which exceeds the university capacity of the world (Boukar, Yusuf & Muslu, 2017).

According to the research conducted by Tint and Win (2014), there are two main types of forgery, type 1 and type 2. Type 1 forgery is when some part of the original document is changed in order to benefit someone who was not benefitted by the original document. In this case, the base substance, normally the paper or plastic card, remains legal and valid, but the information that is contained therein is forged. The second, type 2 forgery is when both the base substance and the information contained therein is fake. However, it is often very difficult to tell whether it is real or fake because the base substance and the style of the document normally look authentic. Tint and Win (2014), outlined the characteristics of the classic unforgeable document. They also outlined three principles of the unforgeable document as follows;

1. The forged document normally has some difference from an authentic original document in some way.
2. The detection of the forgery can happen without reference to the authentic original document.
3. There is a concrete verification method that does not necessarily involve communication with an authentication bureau.

## 2.3.1 Types of documents

Documents are generally classified into two major categories: paper-based documents and digital documents. Paper-based documents include printed text, tables, and symbols, while digital documents are electronic files designed to display visual content on digital screens such as computers or mobile devices Ali and Yusuf (2021). In recent years, document forgery has become increasingly prevalent, compromising the credibility of document holders and the institutions that issue them. According to Adebayo and Musa (2022), document forgery typically falls into two categories: (i) altering portions of an authentic document and (ii) creating an entirely fake document with fabricated information.

The rapid advancement of digital technologies, including high-resolution scanners, printers, and user-friendly image editing software, has significantly lowered the technical barriers to producing convincing forged documents (Nwachukwu & Hassan, 2023). Unfortunately, while the tools for forgery have evolved swiftly, the mechanisms for securing and verifying documents have not kept pace. This technological imbalance has contributed to a surge in the use of counterfeit certificates and identification documents.

As noted by Okonkwo and Bello (2024), many institutions still rely on outdated manual verification methods, making them susceptible to fraud. Therefore, robust and modern document authentication systems are now more important than ever. These systems ensure that documents presented especially in critical sectors such as education, employment, and government are both genuine and verifiably linked to the rightful owners.

## 2.3.2 Paper based document

Boukar *et al.* (2017), attributes that to the lack of verification, there are many cases where documents where forged throughout the globe. For example, one that happened in New Delhi, where five people obtained loans and cheated the banks using fake documents Osman and Omar (2016). Another example is one that happened in Bagdad, an investigation of 20,000 government employees by Iraqi's parliament showed that some employees have used forged educational certificates and fake diplomas to get their jobs. The issue extended in that those employees that used fake certificates became senior officials in the government (Srushti *et al.*, 2014).

Forgery of documents can happen in any discipline or line of work. In U.S. for example, The National Health Care AntiFraud Association projected that United States of America lost 3% to 10% of total healthcare cost to fraud (GeeksforGeeks, 2018). Another example of forgery that happened in an area that involved the medical discipline is in Malaysia. The mainstream newspaper reported that a statement given by the Congress of Unions of Employees in the Public and Civil Services (CUEPACS) stated that more than 45,000 or 3% of 1.5 million government’s staff in Malaysia forged medical certificate as a reason of absence from work to do part-time jobs. Another discipline that was impacted is Education.

With that has been mentioned, document verification is important to overcome many issues that could even do with life and death. Imagine a doctor forging his way into a medical school. Or a politician forging his way to power. As a result, many could be harmed of such a behavior. Document verification of a paper-based document has to be efficient to allow of seamless verification.

## 2.4 Certificate Verification Systems

Certificate verification systems play a crucial role in ensuring the authenticity and integrity of certificates in various domains such as education, healthcare, finance, and legal documentation. Recent studies have focused on developing efficient and secure certificate verification systems, incorporating innovative approaches and technologies. This section presents a review of recent research in this area, highlighting methodologies, advantages, and limitations of certificate verification systems. Researchers have proposed different approaches to certificate verification, aiming to enhance the overall security and reliability of the process. Some studies focus on QR code-based verification systems, leveraging the unique capabilities of QR codes to embed encrypted information and facilitate efficient scanning and decoding. For instance, Hu *et al.* (2021) proposed a lightweight certificate verification system using QR codes for e-commerce, providing a secure and efficient method for verifying product certificates and authenticity. This system utilized QR codes to store encrypted product information and integrated it with a verification algorithm to ensure reliable validation.

In addition to QR codes, other technologies have been explored to enhance the security of certificate verification systems. Blockchain technology has gained significant attention due to its decentralized and immutable nature. Researchers have proposed integrating blockchain with certificate verification systems to establish a tamper-proof and transparent verification process. Kshetri and Voas (2022) presented a trustworthy certificate verification system using QR codes for Internet of Things (IoT) devices, combining QR codes and blockchain to verify the authenticity and integrity of IoT device certificates. The utilization of blockchain technology provides a decentralized and auditable system for certificate verification.

Furthermore, studies have investigated the integration of additional security measures into certificate verification systems. Wang and Li (2023) designed and implemented a certificate verification system using QR codes in higher education, incorporating steganography to enhance the security of embedded information within QR codes. Steganography allows the hiding of information within images, thereby providing an extra layer of security to the certificate verification process.

Advancements in machine learning and artificial intelligence (AI) have also been leveraged to improve the accuracy and efficiency of certificate verification systems. Researchers have explored the use of machine learning algorithms to automate the verification process and detect fraudulent certificates. For example, Li *et al.* (2021) proposed a machine learning-based certificate verification system that utilizes image recognition techniques to analyze and verify the authenticity of certificates.

While certificate verification systems have shown significant advancements, they also face certain limitations and challenges. One of the key challenges is the management of a large volume of certificates and verification requests. Ensuring scalability and efficient data storage and retrieval mechanisms are crucial in maintaining the performance of the system. Interoperability with existing systems and user acceptance are also important factors to consider in the design and implementation of certificate verification systems.

## 2.5 Graduation certificate

A university is an example of an organization that creates so many documents for their students. It issues a certificate and academic transcript for each of its graduates. The certificate contains information that certifies a person has graduated from a certain specialization and obtained results as stipulated in the certificate. The certificate can then be used for job hunting or pursuing academics or any other purpose. The graduation certificate issued by the universities/institutions is one of the important documents for the graduate. It is a proof of graduate’s qualification and can be used anywhere. Every year millions of students graduate from colleges and Universities, and their numbers are growing. Institutions issue certificates to those who have successfully completed the requirements of graduation. A graduation certificate is still in the form of a paper-based document because, as of yet, an electronic document cannot effectively replace a physical certificate (Smartsheet, 2019). With the rise of graduates and advancements in printing and photocopying technologies, came the rise of fake certificates as well threatening the integrity of both the certificate holder and the university that has issued the certificate (Abolaji, 2017).

Graduation certificates must be verified to confirm both the authenticity of their content and the legitimacy of the issuing institution (Ibrahim & Okafor, 2021). With advancements in printing and editing technologies, fake certificates can now be produced with high quality, often making them visually indistinguishable from genuine ones (Akinola & Yusuf, 2022). Even prestigious universities have fallen victim to certificate forgery, and these counterfeit documents can be extremely difficult to detect through visual inspection alone.

Educational institutions have implemented various measures to curb this growing problem, including the use of watermarks, holograms, and manual verification processes (Eze & Mohammed, 2023). However, traditional verification methods remain slow and resource-intensive, often involving direct communication between employers and universities, followed by prolonged waiting periods for confirmation. This approach is not only inefficient and costly, but also impractical particularly when organizations must validate hundreds or thousands of certificates during large-scale recruitment exercises (Nwankwo & Bassey, 2024).

Given these limitations, there is a pressing need for a cost-effective, fast, and scalable solution for certificate verification. A digital system that minimizes human involvement and supports real-time validation such as a QR code-based authentication platform—can significantly reduce both the time and cost associated with verifying academic credentials.

## 2.5.1 Importance of Graduate Certificate

## 2.5.2 Paper-Based Certificate

Despite the growth of digital technologies, paper-based certificates remain widely used, primarily due to the perception that they offer greater authenticity and trustworthiness than digital alternatives (Umar & Adewale, 2021; Okoro & Hassan, 2022). These physical documents often feature official stamps and handwritten signatures, which are seen as strong indicators of originality and legitimacy (Olawale, 2023). Many institutions and employers still mandate the presence of these physical authentication marks before recognizing a certificate as valid, especially in contexts such as graduation, employment, or licensing.

However, a key limitation of paper-based certificates is that holders must repeatedly present the original copy whenever verification is required. This increases the risk of wear, damage, or loss and can be particularly inconvenient in remote or international verification scenarios. Moreover, while paper certificates have practical advantages such as ease of annotation, allowing reviewers to highlight or mark important sections (e.g., during module assessments or transcript reviews), this feature does not compensate for their vulnerability to forgery and lack of real-time validation (Chukwuemeka & Nneka, 2023).

Consequently, while paper certificates are valued for their tangible and recognizable security elements, their limitations in scalability, security, and verification efficiency call for the adoption of enhanced systems—such as QR code-based digital authentication—to bridge the gap between traditional validation methods and modern technological standards.

Paper based certificates despite being widely used they can be damaging. The most important disadvantages are:

1. With paper-based certificates is risk of loss and damage. Paper based certificates can easily be lost especially now as it is easy to relocate between different places and countries.
2. Paper-based certificates is that they can be costly especially if changes are required on the document; for example, a faulty name was printed, more papers would have to be used and that extra cost for the entity issuing the certificate; this indirectly also effects the environment.
3. Paper based certificates can easily be damaged be it a wet hand or a fire in the building; Once the paper documents are damaged, they are usually hard to recover. The holder either has to travel to source to generate the same or if the same is not regenerated it is a loss.
4. Paper based certificates can eventually consume physical space.
5. Paper based certificates can be slow to retrieve.

Despite these drawbacks with Paper based certificates entities still use it.

## 2.5.3 Digital based Certificate

Digital graduation certificates are academic credentials issued in an electronic format through secure certification and verification mechanisms (Okeke & Ibrahim, 2021). They are increasingly adopted as a solution to the logistical challenges associated with managing paper-based certificates, such as physical storage, printing costs, and risk of loss or damage (Chinonso & Bello, 2022). A key advantage of digital certificates lies in their portability—they can be easily transferred, accessed, and shared across platforms without the constraints of physical documentation (Adebayo & Omotola, 2023).

In addition to being eco-friendly, digital certificates reduce clutter and can be efficiently organized without occupying physical space. However, despite these advantages, digital certificates in their basic or unsecured forms are highly susceptible to forgery. The widespread availability of document editing software makes it easy to manipulate or generate fake digital credentials without requiring advanced hardware (Nnaji & Okon, 2023).

Because of this vulnerability, many universities still rely on traditional paper-based certificates as the primary format of issuance. Even in institutions that provide digital credentials, paper-based certificates are often required for official use, particularly in settings where verification infrastructure for digital formats is lacking or untrusted (Ekanem & Abdulraheem, 2024). As such, digital certificates have yet to be fully embraced as a standalone standard in many educational systems.

## 2.6 Models for a Certificate Verification System using QR

Web-based applications are fundamental to modern digital interactions, and their architecture significantly impacts their performance, scalability, and reliability. The choice of architecture model depends on the complexity of the application and its anticipated traffic and usage. Let's delve deeper into the three primary models of web application components with insights from recent literature.

**2.6.1 Incremental‑Encrypted QR Model**

The Incremental‑Encrypted QR Model combines the security of encrypted QR codes with the flexibility of an incremental development lifecycle, allowing for progressive enhancement of system functionality and performance. In the initial phase, certificate data such as the holder’s name, identification number, course of study, and date of issuance are encrypted using symmetric encryption algorithms such as Advanced Encryption Standard (AES‑128) before being embedded in a QR code. This encrypted payload can be decoded only by an authorized application or verification platform equipped with the corresponding decryption key. As a result, the verification process can be conducted offline without exposing sensitive certificate details to unauthorized users, a method that has been shown to enhance security and reduce the risk of tampering (Chen *et al.,* 2018; Dey *et al*., 2018).

Adopting an incremental development methodology enables the system to evolve in discrete, manageable phases. According to Aimufua *et al.* (2022), this approach allows developers to introduce and test new features such as data compression for larger payloads, role‑based access control, digital signatures, certificate expiration metadata, and revocation flags while maintaining backward compatibility with earlier versions. Incremental updates can also incorporate optional backend connectivity for real‑time validation, timestamp verification, and blockchain‑based authenticity checks, while preserving the core offline verification capability for regions with limited or unreliable internet access (Aimufua *et al.,* 2022; Patel & Shah, 2021).

The model offers several advantages. First, the offline verification capability ensures usability in low‑connectivity environments, making it particularly suited for rural or under‑resourced regions. Second, the step‑by‑step implementation minimizes deployment risks and allows for user feedback at each stage, leading to more user‑centric design improvements. Third, the encryption of QR code payloads ensures that even if the code is intercepted, its contents remain inaccessible without the appropriate cryptographic key. However, limitations exist, including the challenge of secure key management, potential QR code data capacity constraints, and the complexity of integrating new online or hybrid verification features while maintaining compatibility with earlier versions (Aimufua *et al.,* 2022; Chen *et al.,* 2018).

## 2.7 Review of Related Work

In recent years, a significant body of work has emerged focusing on the development and deployment of digital solutions for certificate authentication, particularly the use of QR code technology. These works vary in scope, methodology, implementation platforms, and the security measures they adopt. This section reviews key related works to provide a foundation for the present study.

Numerous academic institutions globally have explored the integration of QR code technology to combat the rising cases of certificate fraud. For instance, **Garba and Musa (2023)** developed a QR code-based certification verification system for a Nigerian tertiary institution. Their system enabled employers to scan a QR code on a certificate and be redirected to a secured online portal that displays the certificate's details, thus confirming its authenticity. The authors reported a notable reduction in manual verification requests and increased confidence from stakeholders in the authenticity of issued credentials.

Their system design focused on simplicity and accessibility, ensuring that even users with minimal technical knowledge could use it effectively. They also integrated an administrator dashboard where educational institutions could upload, edit, or revoke certificates, which added to the system’s flexibility and efficiency. However, their study noted that periodic system updates were essential to prevent outdated verification data and to enhance scalability as more users joined the platform.

In another study, **Chen et al. (2022)** implemented a QR code verification model across several universities in East Asia. Their system incorporated a web-based backend that housed student records and provided real-time validation. Their study emphasized the importance of data synchronization and database security, noting that any lapse in these areas could compromise system reliability.

Chen *et al.* further observed that different institutions had varying levels of digital infrastructure, which posed a challenge in standardizing the implementation. They recommended a cloud-based centralized database accessible through institution-specific login credentials to improve data harmonization. Additionally, their work recommended periodic audits and external evaluations to ensure system compliance with international data protection regulations like GDPR and ISO/IEC 27001.

**Adewale and Johnson (2023)** developed a mobile application for certificate authentication using QR codes. The application was designed to scan QR codes on certificates and fetch the corresponding data from a remote database. Their work highlighted the convenience and portability of mobile-based verification systems and the high adaptability of such systems in resource-constrained settings. They further noted that mobile apps reduce dependence on desktop verification systems, thereby increasing accessibility.

Their mobile application was developed using React Native and Firebase, allowing it to run on both Android and iOS platforms. The QR code scanning component was optimized for low-light environments and varying print quality, making it robust and reliable. The developers included offline capabilities whereby once a certificate is verified online, it can be stored locally for future reference, reducing the burden on network connectivity.

Another related work by **Singh *et al.* (2023)** introduced a mobile-based academic record verification tool using both QR and barcode technologies. Their application, built on Android, was used by multiple colleges and received positive feedback for its simplicity and responsiveness. However, they observed challenges in ensuring secure API communication between the app and the cloud-based database.

To address this, Singh *et al.* implemented token-based API authentication and SSL encryption for data transmission. Additionally, their app provided a feedback mechanism for users to report inconsistencies or errors in certificate data, enabling continuous system improvement. They recommended further integration with biometric verification to enhance trust in high-stakes environments, such as employment screening or university admissions.

To enhance the immutability and traceability of verified data, some researchers have explored integrating blockchain technology with QR code systems. **Lee and Martinez (2022)** presented a hybrid system that combined blockchain with QR codes for verifying professional and academic certificates. In their approach, QR codes stored encrypted hashes that matched entries on a blockchain ledger. This made it impossible to alter a certificate without detection. Their solution addressed data integrity and tampering concerns and provided a verifiable audit trail for each certificate issued.

The authors used Ethereum smart contracts to automate the creation and verification of credentials, reducing the need for manual database checks. Each time a certificate was issued, a hash of its content was recorded on the blockchain, and this hash was embedded in a QR code printed on the certificate. During verification, the system simply recalculated the hash and compared it with the blockchain entry, ensuring tamper-proof validation.

Similarly, **Nguyen *et al.* (2024)** proposed a smart contract-based verification system where certificate data was permanently stored on a blockchain network. Their system automatically triggered alerts if discrepancies were found during the verification process. The use of QR codes as access points to this blockchain data ensured that the system remained user-friendly and secure.

Nguyen’s system introduced the concept of digital signatures along with QR codes, offering an added layer of cryptographic security. They also developed a web extension tool that allows HR departments to verify certificates without logging into the system manually. However, one major challenge they reported was the cost associated with blockchain transactions (gas fees), particularly when scaled to thousands of certificates. They suggested exploring Layer 2 solutions such as Polygon or Binance Smart Chain for cost-efficiency.

Beyond academia, governments and private organizations have also adopted QR code verification technologies. For example, **Okonkwo *et al.* (2022)** discussed a national effort in Ghana where vocational certification was transitioned to a digital format, each bearing a QR code for easy authentication. The project significantly reduced the production of fake credentials and allowed employers to verify qualifications in real-time through a government portal.

The Ghanaian system also supported multilingual access and was designed with rural outreach in mind, ensuring compatibility with low-end devices. QR codes were printed with special inks to prevent photocopying, and background watermarks were added for additional visual verification. The project saw a 60% reduction in document falsification within the first year of implementation.

In the healthcare sector, **Rodriguez and Kim (2023)** implemented a system for verifying medical practitioners’ licenses using QR codes embedded in their ID cards. Their research emphasized the role of such systems in preventing impersonation and malpractice, especially in rural areas where regulatory enforcement is weak.

Their system featured a real-time reporting dashboard for medical regulators and hospital administrators to track license expirations and suspensions. Additionally, it integrated biometric validation using facial recognition at healthcare facilities to further confirm the identity of the license holder. The study concluded that QR-based systems, when paired with biometric tech, could revolutionize regulatory enforcement in sectors vulnerable to fraud.

While these systems offer numerous advantages, related studies also reveal some limitations. **Okoro *et al.* (2023)** identified several technical challenges, including poor internet access, lack of user training, and exposure to cyber threats like code spoofing. Their findings stress the need for robust system security such as HTTPS protocols, database encryption, and user authentication mechanisms.

They also pointed out that QR code degradation due to poor printing or environmental wear-and-tear could lead to failed scans. To mitigate this, they recommended embedding error-correcting features in QR codes, using secure cloud hosting, and implementing redundancies such as digital backups accessible via email or mobile number.

Likewise, **Patel and Zhang (2024)** emphasized the importance of deploying secure cloud-based databases to ensure scalability and data integrity. Their system incorporated role-based access control (RBAC) and two-factor authentication (2FA) to mitigate unauthorized data manipulation.

## 2.8 Research Gap

Several studies have proposed techniques for enhancing the verification of paper-based certificates; however, these methods often present notable shortcomings. For instance, Warasart and Kuacharoen (2012) introduced document verification mechanisms that relied on special templates and printing technologies. While effective in some contexts, their approach requires changes to the certificate production process and specialized equipment, which increases cost and complexity. Similarly, Osman and Omar (2016) highlighted the use of institutional manual checks and semi-automated systems, but these methods remain slow, labor-intensive, and unsuitable for large-scale deployment.

Research by Nwachukwu and Igbajar (2015) acknowledged that most existing solutions attempt to curb forgery by integrating additional hardware or embedding hidden information within documents. However, such approaches limit scalability and are incompatible with certificates issued prior to the implementation of the system. Boukar *et al.* (2017) further emphasized the issue of inconsistencies across institutions, noting that variation in certificate formats makes it difficult to adopt a universal verification method, especially in international contexts.

More recent studies have attempted to adopt digital solutions. For example, Lee and Martinez (2022) proposed a blockchain-QR code hybrid system to ensure immutability of academic records. While their work improved data integrity, its reliance on blockchain raised concerns regarding cost-effectiveness due to high transaction (gas) fees, making it less practical for institutions with limited resources. Likewise, Nguyen et al. (2024) introduced smart contract-based verification, but they acknowledged challenges in terms of scalability and user adoption, particularly in environments with limited technological infrastructure.

More recent research continues to push toward more automated, digital-first certificate verification, but novel methods still face challenges. For example, Patel *et al.* (2024) proposed a secure digital academic certificate verification system combining timestamps, hash functions, digital signatures, steganography, and blockchain to produce certificates that are traceable, accurate, time-saving and purportedly cost-effective. While this approach strengthens data integrity and non-repudiation, it still depends heavily on digital infrastructure: institutions need stable Internet, capable servers, and in many cases clients with the ability to verify signatures and hashes. Additionally, the inclusion of steganography, while clever, increases implementation complexity and may not be robust in degraded or scanned copies of old paper certificates.

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Other studies have explored mobile-first and hybrid approaches with an eye toward reducing technological barriers. For instance, Samad, Kamarzaman, and colleagues (2025) introduced a blockchain-based mobile verification system using Android applications and Ethereum smart contracts, while Ifeyemi, Oyedeji, and Adebiyi (2024) designed a QR-code-based blockchain verification system tailored to Nigerian institutions. These solutions reduce reliance on manual checks, but they still assume that all certificates can be digitized and onboarded, which is costly and time-consuming.

Several works address cost reduction and scalability, yet trade-offs emerge around standardization, user acceptance, and interoperability. For example, Dela Cruz et al. (2024) designed a national blockchain credential verification system in the Philippines using Polygon, while Shah et al. (2023) proposed Verifi-Chain, which integrates blockchain and IPFS to reduce storage costs. Although these systems reduce some barriers, they do not solve issues related to legacy certificates or connectivity in resource-limited environments.

Despite progress on digital standards, interoperability and adoption remain incomplete. The World Wide Web Consortium (W3C, 2023) has advanced Verifiable Credentials (VC) 2.0 to standardize tamper-evident records, but adoption across institutions is uneven, and schema fragmentation complicates universal verification. As a result, low-cost, backward-compatible solutions are still necessary.

Algorithmic forgery detection using machine learning has also shown promise. Recent studies (Li *et al.,* 2023; Zhao & Ahmed, 2022) demonstrate high accuracy in detecting anomalies in scanned certificates. However, these systems often fail in real-world conditions, where lighting variations, low resolution, and adversarial forgeries reduce accuracy. Moreover, models trained on local datasets lack generalizability to international certificate formats.

Finally, blockchain-IPFS hybrids and decentralized identity (DID) solutions have been proposed to reduce storage costs and enhance user control (Chen et al., 2023; Bistarelli & Santini, 2024). Yet, they remain impractical in settings with poor connectivity, high onboarding costs, and limited legal recognition of digital credentials. There is thus a clear need for hybrid verification systems that balance cost-effectiveness, offline compatibility, and institutional trust, while remaining backward-compatible with both old and new certificates.

Nor Hafiza Abd Samad, Nor Shamshillah Kamarzaman *et al.* (2025) on Blockchain Technology for Secure and Efficient Mobile Certificate Verification uses a mobile Android app plus Ethereum smart contracts to automate the verification process. Similarly, the case in Nigeria — “A Blockchain-Based Digital educational certificate verification system (BCVS)” by Ifeyemi, Oyedeji & Adebiyi (2024) stores certificate hashes and metadata on a blockchain (using Celo), with QR-code-based verification. These solutions reduce reliance on manual checks, and make verification more accessible via mobile devices and QR scanning. However, they still assume that all certificates (including older, purely paper ones) can be backlogged into the system (i.e. someone must scan / digitize or reissue them), which can be costly and time-consuming. Also, revocation mechanisms and maintaining metadata (e.g. which institution issued what, maps of formats) remain weak or only partially addressed.

Therefore, despite these advancements, existing solutions are either too costly, technologically demanding, or limited to specific contexts. There remains a clear need for a verification approach that is cost-effective, requires minimal infrastructural changes, is backward-compatible with both old and new certificates, and can function seamlessly across diverse domains and uncontrolled environments.

# CHAPTER THREE

# METHODOLOGY

## 3.1 Overview

This chapter provides an in-depth analysis and design of the proposed Certificate Verification system, focusing on its benefits and improvements over existing verification process. It begins by evaluating the current systems both manual and automated highlighting their limitations such as inefficiency, outdated information, and challenges in matching tutors with students. The discussion then shifts to the proposed system, which addresses these issues with enhanced efficiency, real-time updates, advanced matching algorithms, and a user-friendly interface. The system's advantages include improved accuracy in tutor-student matches, robust data management, scalability, and flexibility, all contributing to a more effective solution for managing tutor allocations and student inquiries.

Additionally, the chapter outlines the hardware and software requirements necessary for implementing the Certificate Verification system, detailing the technical specifications for both server and user devices. It describes the system architecture and design, including the interaction between various components and the design of user interfaces. The methods of data collection used for this study are also covered, with a focus on primary sources such as interviews and questionnaires, and secondary sources like academic journals and industry reports. The chapter concludes by addressing the transition from manual processes to an automated system, outlining the implementation plan, potential challenges, and solutions to ensure a smooth and successful deployment.

The proposed Certificate Verification system also incorporates advanced search and filtering capabilities, allowing administrators to refine their search based on specific criteria such as date, department, course. This feature significantly enhances the user experience by providing tailored results that align closely with the institution needs. Furthermore, the system’s backend is designed to support real-time communication between tutors and students, enabling immediate interactions that facilitate quicker decision-making and scheduling. The integration of notifications and reminders ensures that both parties remain informed of upcoming sessions and any changes, thereby reducing the likelihood of missed appointments or misunderstandings.

Moreover, the chapter explores the security measures implemented to protect user data and ensure privacy. Given the sensitive nature of the information exchanged within the platform, such as personal details and payment information, the system employs encryption and secure authentication methods to safeguard against unauthorized access. Regular security audits and updates are planned to maintain the integrity of the system. The chapter emphasizes the importance of these security features in building user trust and ensuring compliance with relevant data protection regulations. The proposed system, therefore, not only improves the efficiency of finding and connecting with tutors but also provides a secure and reliable platform that users can confidently rely on.

## 3.2 Methods of Data Collection

For this study, both primary and secondary data were utilized. The primary data was obtained directly through the administration of questionnaires and, where necessary, interviews with relevant respondents. These instruments provided firsthand information that reflected the perceptions, experiences, and opinions of participants on the subject under investigation. In addition, secondary data was gathered from existing scholarly and documented sources, including journal articles, textbooks, newspapers, magazines, and other relevant library resources. These secondary materials offered theoretical foundations and supported the interpretation of the primary data, while also helping to highlight trends, gaps, and findings from previous studies.

## 3.3 System Analysis

## 3.3.1 Analysis of the Existing system

Figure 3.1 shows the existing system architecture of Certificate verification method that is prevalent today is a manual process, in this process the institution/organization that want to verify a result will have to make a trip to the university or send a written request so as to verify result. The request will then go to academic affair which refer to the library or safe files to look for the duplicate certificate, this can really be time consuming, also sometimes files are lost when moved from one office to another, and in some cases, can be missing or be difficult to locate.

The registrar might be very busy with so many other letters and thereby read the letter late. It will take a while for the letter to be replied and sent back. The body that wants to verify a certificate can equally send a representative to the school; such trip will end up costing the body that needs to verify the certificate. The manual method of verifying the certificate is usually cost incurring, not fast, prone to error etc.

**ADMIN**

**CERTIFICATE VERIFICATION**

System Database

Figure 3.1: System Architecture (Osman & Omar, 2016)

## 3.3.2 Problems of the Existing System

Such conventional methods pose several drawbacks:

1. Time-consuming processes: Manual allocation procedures, involving paperwork and face-to-face coordination, can significantly consume time. This can lead to delays in tutor allocation and scheduling.
2. Administrative burden: Managing and verifying certificates manually requires considerable administrative effort, including record-keeping, communication, and scheduling. This increases the workload for departmental staff and can lead to inefficiencies and errors.
3. Limited access to information: Manual systems may not provide easy access to comprehensive tutor profiles, leading to suboptimal matching between tutors and students based on skills and preferences.

## 3.4 Proposed System

System design for the Certificate Verification involves defining the platform's architecture, modules, interfaces, and data structures to meet specified requirements. It entails the application of systems theory to product development, ensuring the alignment of design elements with the objectives and needs of the institution.

The proposed Certificate Verification system offers numerous advantages over manual allocation methods by streamlining the process of generating certificates with student details such as name, registration number, and quick response (QR) code, thereby reducing the time required for verification. It significantly reduces administrative workload through automation, allowing departmental staff to focus on other critical tasks, while enhancing accessibility by enabling employers to easily verify certificates based on qualifications and reviews. Additionally, the system provides flexibility and convenience for both institutions and employers of labor to perform verifications online, and improves transparency and accountability by maintaining clear records and minimizing the risk of fraudulent documents.

## 3.4.1 System Architecture

Figure 3.2 shows the system architecture for the Certificate Verification defines the overall structure and components of the system, ensuring that all parts work together to meet the specified requirements. This architecture is designed to support a scalable, efficient, and user-friendly platform for managing certificates verification interactions.

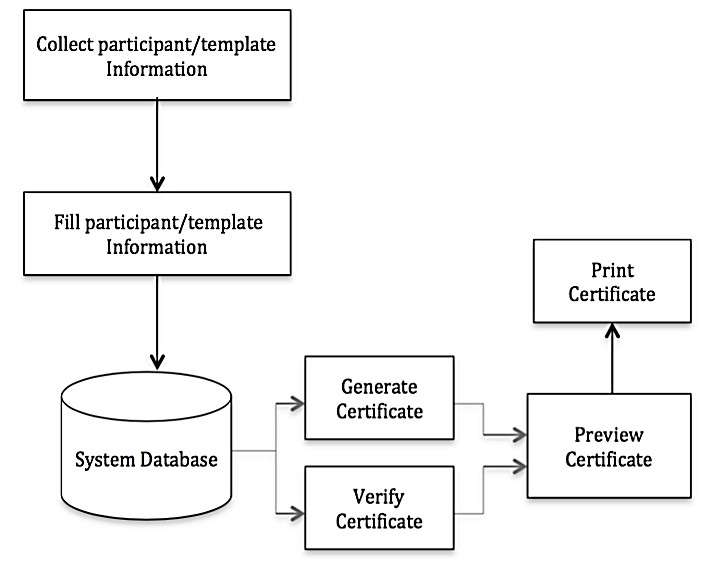


Figure 3.2: System Architecture

3.4.2 Algorithms  
The certificate verification system relies on a set of algorithms that guide its core operations. The main algorithm ensures that each certificate entered into the system is validated accurately against the stored database records. When a user submits a certificate number, the algorithm performs a search and comparison process to check for authenticity.

The steps followed by the algorithm are:

1. Accept the certificate input details from the user.
2. Query the database to locate a matching record.
3. If a match is found, retrieve and display the certificate details.
4. If no match is found, return an error message indicating that the certificate is invalid or not available.
5. Log each verification attempt for auditing and security purposes.

This approach ensures quick, accurate, and secure validation of certificates while minimizing errors and fraudulent activities.

## 3.5 System Design

System design for the Certificate Verification System involves defining the platform's architecture, modules, interfaces, and data structures to meet specified requirements. It entails the application of systems theory to product development, ensuring the alignment of design elements with the objectives and needs of the system.

## 3.5.1 Use case diagram

Figure 3.3 shows the use case diagram at its simplest is a representation of a user’s interaction with the system and depicting the specifications of a use case. A use case diagram shows the system and the various ways that they interact with the system.

Admin

Verifier

Figure 3.3: Use case diagram

## 3.5.2 Flow Chart Diagram

Figure 3.4 shows the Flow chart diagram shows a flow of control in a system similar to a data flow diagram.

Start

Scan QR Code

Stop

Display Certificate

Is certificate record available?

NO

YES

Figure 3.4: Flowchart Diagram for the system

## 3.5.4 Database Tables/Queries Structures

The database is used to store all information that pertains to the Certificate Verification records. Below are the database tables for the new system.

**Admin**

Table 3.1 stores information related to system administrators who manage the tutor-finding system. Each record represents an individual admin with a unique identifier (id), a username for login (username), and a password for authentication (password). The id field is an auto-incrementing integer that uniquely identifies each admin, while the username and password fields are used to grant and verify access to the system.

**Table 3.1: Admin**

**Top of Form**

| **Name** | **Type** | **Extra** |
| --- | --- | --- |
| **id Primary** | int(11 | AUTO\_INCREMENT |
| **Name** | varchar(50) |  |
| **Department** | varchar(255) |  |
| **EmailId Index** | varchar(50) |  |
| **MobNo** | bigint(11) |  |
| **Password** | varchar(50) |  |

**Certificate Records**

Table 3.2 contains details about the certificates available on the institution database. Each record includes a unique identifier (id), full name (Fullname), the course of study (Course), their gender (Gender), date of birth (Date of birth), email address (Email), Quick response code (QRcode), and registration number (regnum). This table helps in managing and retrieving information about certificates for scheduling and inquiry purposes.

**Table 3.2: Certificate Records**

**Top of Form**

**Top of Form**

| **Name** | **Type** | **Extra** |
| --- | --- | --- |
| id Primary | int(11) | AUTO\_INCREMENT |
| Student\_id | varchar(250) |  |
| qrcode | varchar(250) |  |
| Date | Timestap() |  |

**Students**

Table 3.3 shows the Student/Inquiry Table tracks inquiries submitted by students regarding tutoring services. Each record has a unique identifier (id), and includes foreign keys linking to the relevant tutor (tutor\_id) and course (course\_id). Additional fields capture the student's full name (fullname), email address (email), contact information (contact), the content of their message or inquiry (message), the status of the inquiry (status), and the date and time the inquiry was created (date\_created). This table facilitates the management and follow-up of student inquiries, providing a structured way to handle requests and track their progress.

**Table 3.3: Students**

| **Name** | **Type** | **Extra** |
| --- | --- | --- |
| id Primary | int(11) | AUTO\_INCREMENT |
| Studentid Index | varchar(250) |  |
| Studentname | varchar(250) |  |
| Age | varchar(250) |  |
| Gender | varchar(250) |  |
| Level | Vacrchar(250) |  |
| Department | varchar(255) |  |
| image | varchar(255) |  |

## 3.5.5 Database Entity Relationship Diagram

Figure 3.4 shows Database Entity Relationship Diagram (ERD) is a visual representation of the data structures within a database and the relationships between them. It provides a high-level overview of the database design, illustrating how different entities (such as tables) are interconnected. The ERD helps in understanding the organization of data and the relationships that define how data in one table relates to data in another.

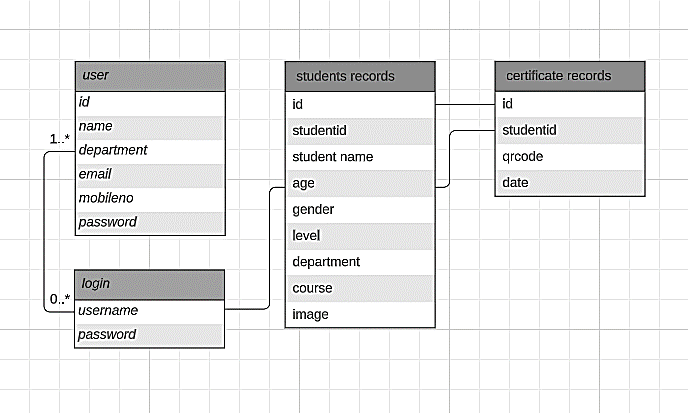


Figure 3.4: Database Entity Relationship Diagram

## 3.6 Software Development

## 3.6.1 Iterative and Incremental Model

The proposed system adopts the Iterative and Incremental Model, a software development methodology that combines the benefits of incremental development building the system in small, manageable components with iterative refinement, where each component is continuously improved based on testing and feedback. This approach ensures that the system evolves gradually, delivering usable functionality early while allowing for continuous enhancement and adaptation to user needs. In this model, the project is divided into small, repeatable cycles (iterations), and in each cycle, a new piece of functionality is developed and integrated into the existing system. Each iteration builds upon the previous one, incorporating user feedback and refining system features. As a result, the final product is delivered as a series of progressively more complete versions rather than as a single large release at the end.

**Stages of the Iterative and Incremental Model**

1. **Requirements Gathering and Analysis**: During this stage, essential system requirements are defined, including details about certificate holder data, course information, issuance dates, and unique identifiers for QR code generation.
2. **System Design and Planning**: Based on the gathered requirements, the overall system architecture and design are developed. This includes decisions about the database structure, user interfaces, security protocols, and integration points.
3. **Initial Implementation (First Iteration)**: The first development cycle focuses on building the **core functionality** of the system. This typically includes generating QR codes containing either encrypted certificate data or unique verification keys linked to a central database.
4. **Testing and Evaluation**: After implementation, the system undergoes thorough testing to identify and resolve bugs, performance issues, or security vulnerabilities.
5. **Subsequent Iterations and Enhancements**: Each new iteration builds upon the previous version by adding new features, refining existing functionalities, and improving the user experience.
6. **Deployment and Maintenance**: Once the system meets all functional, security, and usability requirements, it is deployed for real-world use. Ongoing maintenance ensures that the system remains secure, efficient, and adaptable to changing user needs or technological advancements.

## 3.6.2 Technologies

The proposed system will be designed using HTML, PHP and MySQL as the database management programming languages for keeping records of the tutor finder system. The design also uses the Responsive type of web design where the content of the website fits exactly and the content is not loss when viewed on different device screen sizes and types. Also, the website is compatible when viewed on different browsers from device to device.

1. **PHP** will manage server-side logic, database interactions, and dynamic content generation.
2. **MySQL** will serve as the backend database, storing and retrieving all system data securely.
3. **JavaScript** will enhance the system's interactivity, perform client-side validation, and enable dynamic content updates.
4. **HTML/CSS** will structure the content, provide a clean and responsive design, and ensure compatibility across devices and browsers.

## 3.7 System Requirements Specification

## 3.7.1 Hardware Requirements

The software to be design needs the following hardware for an effective operation of the newly designed system.

1. A system running on intel, P(R) duo core with higher processor
2. The-Random Access Memory (RAM) should be at least 512MB.
3. At least 20-GB hard disk.
4. A monitor.

## 3.7.2 Software Requirements

The software requirements include:

1. A window 7 or higher version of operating system.
2. XAMP or WAMP for Database
3. PHP
4. MySQL
5. Browser

## 3.7.3 Personnel Requirements

Any computer literate who has a technical knowhow of internet surfing can use the system because it is user friendly.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Overview

The new system is designed using PHP and MySQL programming language for easy records inserting and updating. This system will help in managing and easily retrieving of information from the system for management purposes. The Certificate Verification system using Quick Response code with aid the process of verifying academic certifications with less stress and time and also, reduce human efforts.

## 4.2 Results

## 4.2.1 Login Interface

Figure 4.1 shows the system login page interface. The login interface allows the Administrator to enter his username and password to get access to the system. This section prevents or guides against unauthorized access into the system.

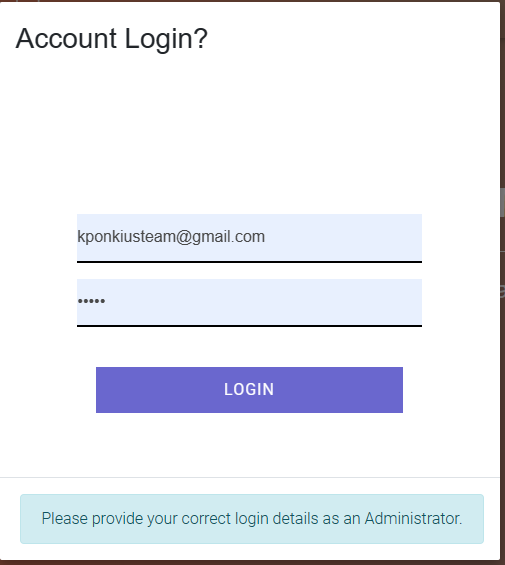


Figure 4.1: Login interface

## 4.2.2 Admin Dashboard

Figure 4.2 shows the system admin dashboard interface. The dashboard interface shows all the tasks that can be performed by the Administrator such as register student, generate certificate and generate a QR code, update records, etc.

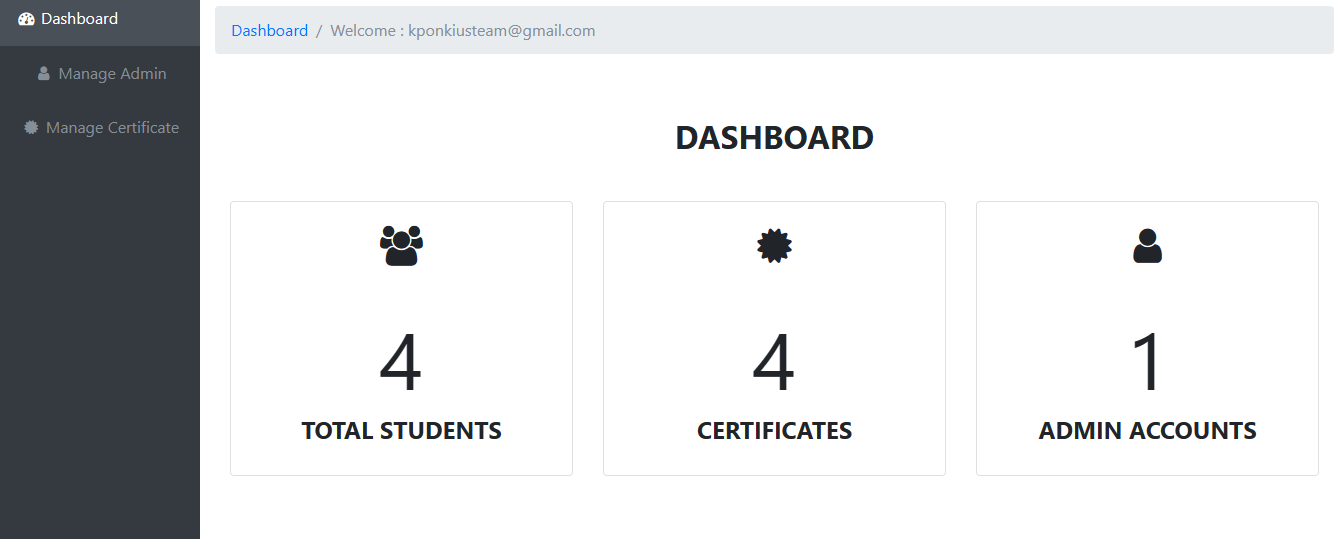


Figure 4.2: Admin Dashboard

## 4.2.3 Add Certificate Interface

Figure 4.3 above shows where certificate can be generated or added into the system to enable the printing and verification of the certificate.

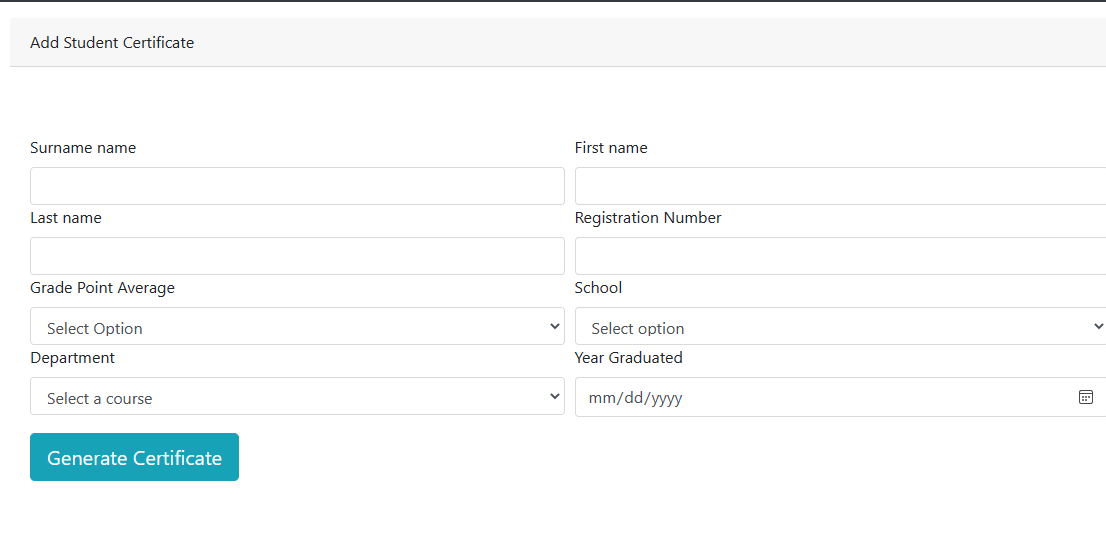


Figure 4.3: Add Certificate Interface

## 4.2.4 Generate QR Code Interface

Figure 4.4 shows the section of the system used to generate a unique QR code for a particular certificate that has been generated.

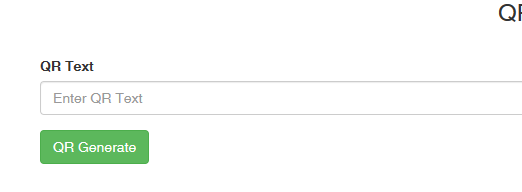


Figure 4.4: Generate QR code Interface

## 4.2.5 Certificate Records Interface

Figure 4.5 displays all the certificate records generated with their unique QR code and certificate code, showing the name of the student, course, school, year of graduation and grade.

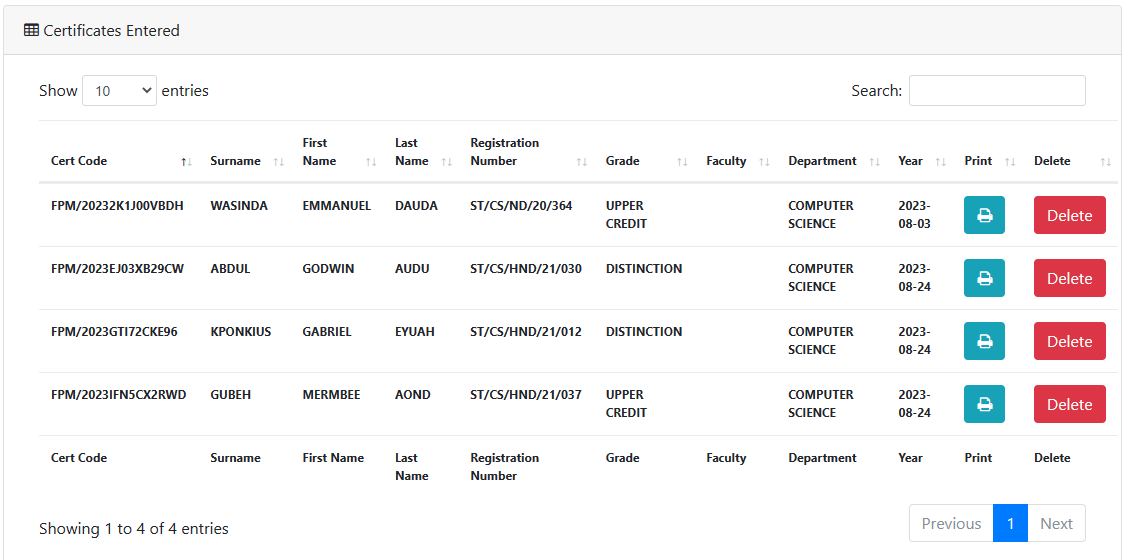


Figure 4.5: Certificate Records Interface

## 4.2.6 Certificate Interface

Figure 4.6 shows the generated certificate with information of the owner and the certificate code and QR code of the certificate for verification purpose.



Figure 4.6: Certificate Interface

## 4.2.7 Verification interface

Figure 4.7 shows the verification interface of a certificate using the certificate code that is printed on the certificate.

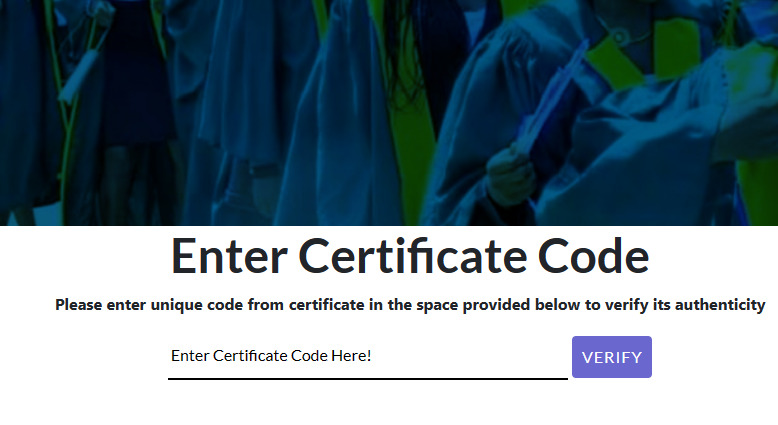


Figure 4.7: Verification Interface

## 4.2.8 Verification Result Interface

Figure 4.8 shows the result of a verified certificate using the certificate code on the certificate displaying the information to the ownership of a certificate code entered.

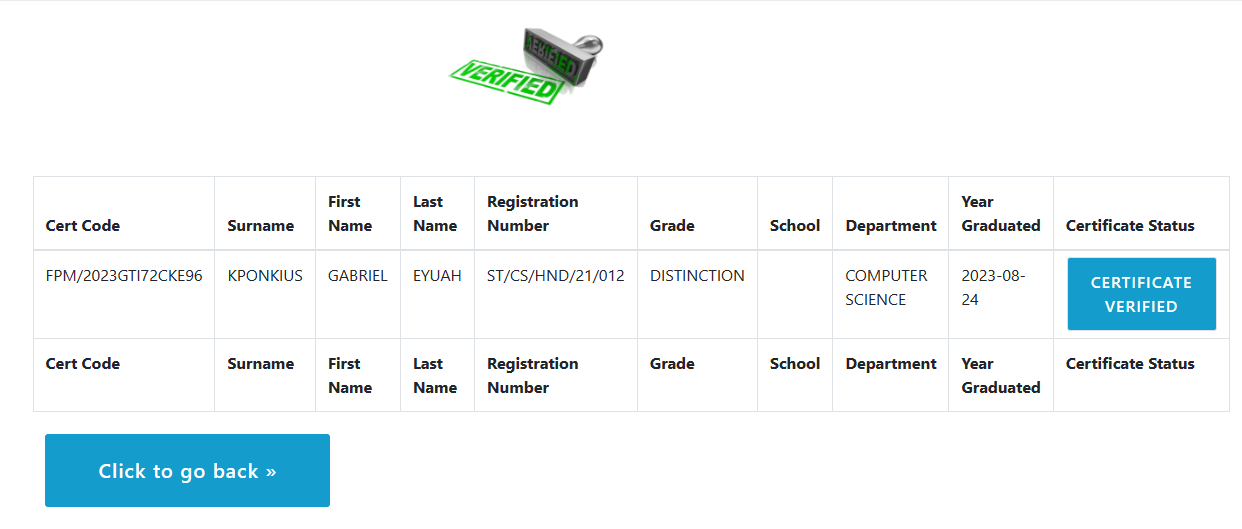


Figure 4.8: Verification Result Interface

## 4.3 Discussion

Login Interface: This serves as the entry point into the system. Users are required to provide valid credentials such as a username and password before gaining access. This authentication step ensures that only authorized individuals can use the system, thereby maintaining data integrity and security.

Admin Dashboard: Once logged in, administrators are directed to the dashboard, which provides a centralized overview of the system. From here, administrators can manage users, certificates, and verification records. The dashboard acts as the control hub, ensuring that all administrative tasks can be performed efficiently.

Add Certificate Interface: This interface allows administrators to upload new certificates into the system. Details such as the certificate number, issuance date, recipient name, and issuing authority can be recorded. By centralizing this process, the system ensures easy tracking and prevents duplication.

Certificate Records Interface: Shown in Figure 4.4, this section provides administrators with access to the full list of certificates stored in the database. Each record includes comprehensive details that can be retrieved or updated when necessary. This makes certificate management transparent and organized.

Certificate Interface: As illustrated in Figure 4.5, certificate holders can log in and view their own certificates. The system may also provide options to download or print certificates for offline use. This feature enhances accessibility and empowers certificate owners with control over their records.

Verification Interface: External users or organizations that wish to validate a certificate can use this interface. As shown in Figure 4.6, they can either scan a QR code embedded on the certificate or manually input the certificate number to initiate the verification process.

Verification Result Interface: Finally, the system provides verification results, as seen in Figure 4.7. Users are informed whether the certificate is authentic or fraudulent. Additional details such as the certificate owner, issuing authority, and date of issuance may also be displayed. This builds trust and assures stakeholders of the certificate’s validity.

In summary, Figures 4.1 to 4.7 illustrate the different interfaces that collectively ensure the Certificate Verification System is secure, user-friendly, and reliable. The logical flow between these interfaces guarantees efficiency in certificate management and verification. These sections collectively form a comprehensive Certificate Verification System using QR codes, ensuring the security and authenticity of certificates while providing a user-friendly interface for both administrators and certificate recipients.

## 4.4 User manual

The following are the necessary steps to take in order to use the system efficiently and effectively.

1. Load the url of the system <https://localhost/certdev/> the welcome page will be displayed.
2. Click on the **Proceed** button to proceed to the main system.
3. If you created an account, provide your login details by entering your username and password.
4. Depending on the login details provided you will be automatically directed to the dashboard.
5. The various task that you can perform on the portal will be displayed on the sidebar of the dashboard.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1 Summary

In this chapter, we provide a comprehensive summary of the design and implementation of a Certificate Verification System using QR code. Throughout this study, we have explored the various aspects of creating a secure and efficient system for verifying certificates using QR codes. This chapter summarizes the key findings, conclusions, and recommendations based on our research and implementation. In summary, it is the main objective of the system to provide an easy to use application that acts like a personal assistant by providing employer with an optimally planned schedule and easy confirmation of certificates. To optimize process taking into account various user constraints as well as other information like location of activities, their duration, and travel signal strength depending on mode of internet connectivity. Provide flexibility by offering to reload to accommodate any eventuality, provide access to user anytime and anywhere and linked to the central server and also, provide a web interface and/or other application.

## 5.2 Conclusion

In conclusion, the implementation of the Certificate Verification System using QR code brings forth a modern and efficient solution for Verifying academic certificates in Federal Polytechnic, Mubi. The various interfaces, certificate generation, QR code generation, unique, certificate code and printing, collectively contribute to a comprehensive and integrated certificate verification process. By digitizing and automating these processes, the system enhances accuracy, reduces manual efforts, and forgery of academic certificates and provides both institutions and employers with a convenient and effective means of engagement. The successful deployment of this system demonstrates its potential to revolutionize the way of verifying certificates, improving overall efficiency and ensuring the authenticity of academic certificates.

## 5.3 Recommendations

1. While the Certificate Verification System has proven to be effective, there is room for improvement and expansion. Based on our research and implementation, we recommend the following:
2. Continuous monitoring and updating of the system to stay ahead of potential security threats.
3. Integration with blockchain technology to enhance certificate immutability and transparency.
4. Collaboration with educational institutions, government agencies, and organizations to encourage widespread adoption.
5. Development of a mobile application for easier and more accessible certificate verification.
6. Implementation of multi-factor authentication for added security.

## 5.4 Contribution to Knowledge

This research and implementation have contributed to the existing knowledge in the field of certificate verification and QR code technology. Our contributions include:

1. A comprehensive design and implementation of a secure Certificate Verification System using QR codes.
2. Insights into the advantages and challenges of using QR codes for certificate verification.
3. A model for enhancing security and user-friendliness in certificate verification systems.
4. A framework for future research and development in the field of certificate verification technology.

## 5.5 Area for Further Work

While this study has achieved its objectives, there are several areas for further research and improvement:

1. Integration of biometric authentication for enhanced security.
2. Exploration of machine learning algorithms for fraud detection.
3. Development of a standardized format for QR codes in certificate verification.
4. Investigating the scalability of the system for large-scale deployment.
5. Conducting user experience studies to fine-tune the system's usability.

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